A Preliminary Study of the Predictive Value of the *IPAT*

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Articulation test scores for 278 subjects with cleft palate were compared with the normative data of Templin and Darley on the Iowa Pressure Articulation Test and the Templin-Darley Screening test of Articulation. In addition the *predictive value* of the *Iowa Pressure Articulation Test* in relation to the need for secondary management was examined.

The results indicate that, at no age level between four and ten years, do more than 9 per cent of the subjects achieve the mean on the IPAT without secondary management. Examination of the data in regard to *"risk rates"* indicates that the IPAT is very useful in predicting the need for secondary management. Subjects who obtained scores of zero on the IPAT at four and one-half years of age had a 96 per cent risk of requiring secondary palatal management.

Descriptive studies of the articulation of individuals with cleft palate have indicated that as a group they are retarded in articulation skills. Although numerous articulation tests are available, the two Templin-Darley tests (Templin and Darley, 1960) are particularly useful because they are normative data for them. Scores on the 50-item Templin-Darley Screening Test of Articulation can be compared with cut-off scores which separate subjects with adequate articulation from those with inadequate articulation between the ages of three and eight. It is at age eight that most children achieve essentially normal articulation. The 176-item Diagnostic Test provides a more comprehensive view but also provides normative data. It was from this test that the 43-item Iowa Pressure Articulation Test (IPAT) was developed by Morris, Spriestersbach, and Darley (1961). The IPAT test proports to discriminate between those subjects who achieve velopharyngeal closure and those subjects who do not. It should be noted that Morris's subjects averaged more than 10 years of age. The youngest subject in the group was age five. To our knowledge no cross-sectional normative data have been published specifically on the IPAT for children with clefts. However, Templin and Darley have provided norms and standard deviations for normal subjects for the IPAT based on data from the original subject group studied by Templin.

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No data have been published recently by which comparisons can be made between the articulation proficiency of children with cleft palate and that of normals. In addition there is the question of whether such comparisons are useful in predicting future status of articulation skills. The question of prediction is especially important in clinical management.

Purpose

The purpose of this preliminary clinical investigation was to determine what per cent of our patients with clefts of the palate, with or without cleft lip, achieve the norms reported by Templin and Darley at given ages for the above tests. Our second purpose was to determine whether, in retrospect, articulation scores on the IPAT were predictive of the eventual need for secondary management.

Procedure

Articulation tests were routinely administered to a large number of patients on a longitudinal basis at specified ages. Articulation tests considered in this study were for children from ages four to 10 and were collected from 1962–1975. 1248 articulation tests were available for 278 subjects. These were computer-scored according to the method suggested by Van Demark and Tharp (1973). The tests were scored on a right-wrong basis, and scores were subsequently rank-ordered for a given age level according to the per cent of sounds which were correct. This procedure yielded information as to the number of per cent of subjects who achieved scores at or above the *mean* of the IPAT and Templin-Darley Screening Test (both reported by Templin and Darley) as well as the number and per cent of subjects who achieved scores which were one and two S. D.'s *below* the mean.

The second question was addressed by using the same computer program with the addition of the date of articulation examination and the date of secondary management,[1] if any. Thus it could be determined whether the articulation test preceded or followed a secondary procedure. From this report the risk rates for secondary management were calculated.

Results and discussion

Table 1 shows the number and percentage of subjects at the eight age levels who achieved scores on the IPAT at or above the appropriate Templin-Darley norm and one and two standard deviations below the norm. The subject group is divided into two subgroups: those who had had only primary surgery on the palate and those who had had both primary and secondary surgery. The results indicate that, at no age level

[1] During the time these data were being collected, the major secondary palatal management procedure used at our center was the pharyngeal flap. Thus, the two terms "secondary management and pharyngeal flap" are used interchangeably in this paper. The principle under considération in our prediction attempts applies to all secondary palatal procedures, however.

TABLE 1. Number and percentages of subjects who achieved scores on the Iowa Pressure Articulation Test at or above the mean, 1/S.D. below the mean, and 2 S.D. below the mean, for the various age levels tested. Scores are presented first for those subjects with primary surgery followed by scores for subjects with primary and secondary management.

age	*n*	*primary only* *n*	*above mean* %	*primary and secondary*		*primary only* *n*	*1 s.d. below* %	*primary and secondary*		*primary only* *n*	*2 s.d. below* %	*primary and secondary*	
				n	%			*n*	%			*n*	%
4	147	6	4.1	–	–	13	8.8	–	–	26	17.7	–	–
4½	158	11	7.0	–	–	17	10.3	–	–	24	15.2	–	–
5	163	11	6.7	–	–	13	8.0	–	–	37	22.7	9	5.5
6	194	14	7.2	–	–	31	16.0	2	1.0	34	17.5	11	5.7
7	180	8	4.4	1	.1	16	8.9	3	1.7	12	6.7	1	.1
8	148	8	5.4	4	2.7	6	4.1	2	1.4	8	5.4	3	2.0
9	133	8	6.0	3	2.3	7	5.3	7	5.3	10	7.5	5	3.0
10	111	10	9.0	8	7.2	12	10.8	2	1.8	7	6.3	8	7.2

TABLE 2. Number and percentage of subjects who achieved scores on the Templin Darley Screening Test of Articulation at or above the mean, 1 S.D. below the mean, and 2 S.D. below the mean for the various age levels tested. Scores are first presented for those subjects with primary and secondary managment.

age	*n*	*primary only* *n*	*above mean* %	*Primary and secondary*		*primary only* *n*	*1 s.d. below* %	*primary and secondary*		*primary only* *n*	*2 s.d. below* %	*primary and secondary*	
				n	%			*n*	%			*n*	%
4	132	9	6.8	–	–	14	10.6	–	–	16	12.1	–	–
4½	145	12	8.3	–	–	21	14.5	–	–	26	17.9	3	2.1
5	157	15	9.6	–	–	19	12.1	4	2.5	36	22.9	6	3.8
6	194	17	8.8	–	–	34	17.5	4	2.1	33	17.0	11	5.7
7	178	4	2.2	1	.6	14	7.9	1	.6	10	5.6	–	–
8	148	12	8.1	3	2.0	8	5.4	3	2.0	11	7.4	–	–
9	133	8	6.0	5	3.8	9	6.8	6	4.5	17	12.8	4	3.0
10	111	13	11.7	7	6.3	11	9.9	8	7.2	11	9.9	7	6.3

between four and 10 years, did more than 9% of the subjects achieve the mean (50%) on the IPAT without secondary management. Less than 25% achieved a score above one standard deviation (68%) below the mean.

Table 2 shows the same data for the subjects on the Templin-Darley Screening Test of Articulation, and the trends are highly similar between the two tests. In general, slightly higher percentages of subjects achieved the mean score or higher or scores that were one standard deviation below the mean on this test than was the case on the IPAT. Fewer subjects obtained scores on the screening test that fell between the norm (mean) and 1 S. D. below the mean than was the case for the IPAT.

In summary, these data once again confirm a finding reported by many investigators during the past 25 years. As a group, children with cleft palate in this study demonstrated seriously impaired articulation skills.

We examined the data in several ways to approach the general problem of prediction. One method was to determine the articulation scores

(in percentages) for specified age levels. From the per cent correct, a "risk level" was determined by examining the number of subjects who were in fact subsequently managed secondarily. For example, Table 3 demonstrates that, for the 147 subjects who were age four, 27 subjects had scores of zero per cent correct; 36 had scores between 1 and 10% correct. Fourteen had scores between 10 and 20% correct, and so forth. Three of these 147 subjects had already had pharyngeal-flap surgery by the age of four years and are shown in the second column according to where their articulation score ranked.

The third and fourth columns present the number and percentage of the remaining subjects who subsequently had pharyngeal-flap surgery after the age of four years. Subjects who had already had the surgery by that time are excluded.

Examination of Table 3 indicates that none of the four-year-old subjects subsequently had secondary management if they achieved a score above 20% on the IPAT at that age. If their score fell between 20 and 11%, they had a risk of 14% (two of 14 subjects) that secondary management would be done. If they achieved a score between 10 and 1%, they had a risk of 46% (16/35). If they acheived a score of zero, they had a risk of 77% (20/26). It is of interest to note that, at age four and one-half, 96% of the subjects (22/23) who achieved zero scores were secondarily managed at a later date.

At age six, subjects with IPAT scores of 30% correct had a 30% chance of subsequent secondary surgery. If their scores decreased to 20% correct, the probability of secondary surgery rose to 60%.

By this method of analysis, it was observed that no subject subsequently had a pharyngeal flap procedure or secondary management of any kind if he achieved the mean on the IPAT for his given age as reported by Templin and Darley (1960). In fact, until age six, no subject had secondary management unless his articulation score was poorer than two standard deviations below the Templin-Darley mean. Examination of the data indicates that no subject had secondary management if he achieved a score of greater than 41% correct before the age of six. In retrospect, only four subjects between the ages of six and 10 with scores above 41% eventually had secondary surgery.

The data presented in Table 3 demonstrate that, as age increased, articulation scores must also increase if the risk of secondary management procedures is held constant. Conversely, if articulation scores do not increase the risk of secondary management increases.

Another method of analysis was to examine the increase in IPAT scores over certain time periods. Because it was our policy for several years to delay pharyngeal-flap surgery until at least age seven, we were able to compare the articulation scores of these subjects before secondary surgery with subjects who were not secondarily managed at specified time intervals. Such data are presented in Table 4. In this way, the average increase in the percentage of correct responses on the IPAT

TABLE 3. Risk rates of the need of secondary palatal management as determined by scores achieved on the IPAT at ages 4, 4 1/2, 5, 6, and 7. N refers to the number of subjects at each age level who achieved the various levels of articulation proficiency expressed in percentages. PF refers to the number of subjects who had had pharyngeal flap procedures prior to the time of test. F refers to the number of subjects who were subsequently secondarily managed and % indicates the percentage of subjects who at specified age leves were subsequently secondarily managed.

	age 4				*age 4 1/2*				*age 5*				*age 6*				*age 7*			
IPAT score % correct	*N*	*flap at exam PF*	*F*	*%*	*N*	*flap at exam PF*	*F*	*%*	*N*	*flap at exam PF*	*F*	*%*	*N*	*flap at exam PF*	*F*	*%*	*N*	*flap at exam PF*	*F*	*%*
100–91	3	0	0	0	3	0	0	0	6	0	0	0	9	0	0	0	14	2	0	0
90–81	3	0	0	0	8	0	0	0	6	0	0	0	13	0	0	0	17	2	1	7.7
80–71	1	0	0	0	4	0	0	0	7	0	0	0	13	1	0	0	15	2	0	0
70–61	8	0	0	0	9	0	0	0	5	0	0	0	20	2	0	0	17	2	0	0
60–51	9	0	0	0	14	1	0	0	21	3	0	0	33	7	0	0	45	12	0	0
50–41	15	0	0	0	11	0	0	0	16	3	0	0	15	5	1	10	16	6	0	0
40–31	15	1	0	0	14	1	2	15.4	18	4	1	7.1	16	2	2	14.3	13	5	1	12.5
20–21	16	0	0	0	30	4	1	3.8	25	1	3	12.5	25	5	6	30.0	10	1	5	55.6
20–11	14	0	2	14.3	19	1	4	22.2	12	2	2	16.7	18	3	9	60.0	9	5	5	100.
10–01	36	1	16	45.7	23	1	12	54.5	31	1	20	66.7	15	4	9	86.7	10	3	6	85.7
00–00	27	1	20	76.9	23	0	22	95.6	16	1	13	86.7	17	2	15	100.	14	2	12	100.
Total SS	147				158				163				194				180			

TABLE 4. Presented are increases in percentage of correct IPAT responses between testings. All tests were done after primary surgery and before secondary surgery.

age range (years)	*subjects with no subsequent secondary surgery*		*subjects with subsequent secondary surgery*	
	n	%	*n*	%
4–4½	29	8.7	21	0.0
4½–5	39	10.3	20	0.0
5–6	29	18.2	16	1.5
6–7	24	17.6	15	3.3

were determined for the two groups. Ages considered were four to four and one-half, four and one-half to five, five to six, and six to seven. For example, Table 4 demonstrates that, at age level four and one-half to five years, the 20 subjects who were later secondarily managed, on the average, made no improvement in articulation scores whereas the 29 subjects who had no secondary management averaged 10.3% improvement. The data indicate that a lack of improvement in test scores is a good indicator that secondary palatal surgery will be needed. There appears to be a fairly constant trend that subjects who require no further surgical management improve atriculation scores by at least 10% each year. However, subjects who ultimately require flaps make little change. Thus it would appear that, although for a specific subject the articulation score may be a good predictor of the need for further management, the percentage of improvement in articulation from observation to observation may be a more reliable criterion in the prediction of the need for secondary management.

In summary, these preliminary findings indicate that 1) it may be possible to calculate risk rates for secondary palatal management on the basis of articulation test scores derived on a simple right-wrong basis and 2) improvement in articulation test scores over specified periods of time may be a better method for arriving at risk rates than are absolute scores. Including information about error type should add even more information for use in arriving at the prediction factor, and we intend to examine that possibility next.

Two limitations to these data must be pointed out: 1) the analysis of the longitudinal data used in this preliminary study was based on group performance of individual subjects over time. Our intent is to address the problem of individual analysis in the near future. 2) There is probably some contamination between the criterion measure (secondary palatal surgery) and the predictor variable (articulation test score) because, at our center, decisions about secondary palatal management are based in part on articulation proficiency. However, at no time is the decision for secondary palatal management made on the basis of an articulation test score alone. Rather, a number of other variables, among them physiological and behavioral indexes to velopharyngeal competence, are used.

We view this study as a preliminary report for the purpose of discriminating among subjects who may need secondary management. We do not advocate that the IPAT should be the only tool used in making such a decision since such a criterion may be misleading, i.e. for specific subjects other factors such as mental retardation, an extreme protrusion of the premaxilla, etc., may contribute to the articulation problem. We do feel, however, that the IPAT appears to be a valid tool in assessing the need for further surgical management. Unlike many diagnostic tests, it is an instrument which requires little time and which can be administered to young children. Although the test is no better than the reliability of the examiner, it seems to be valuable to collect scores systematically.

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